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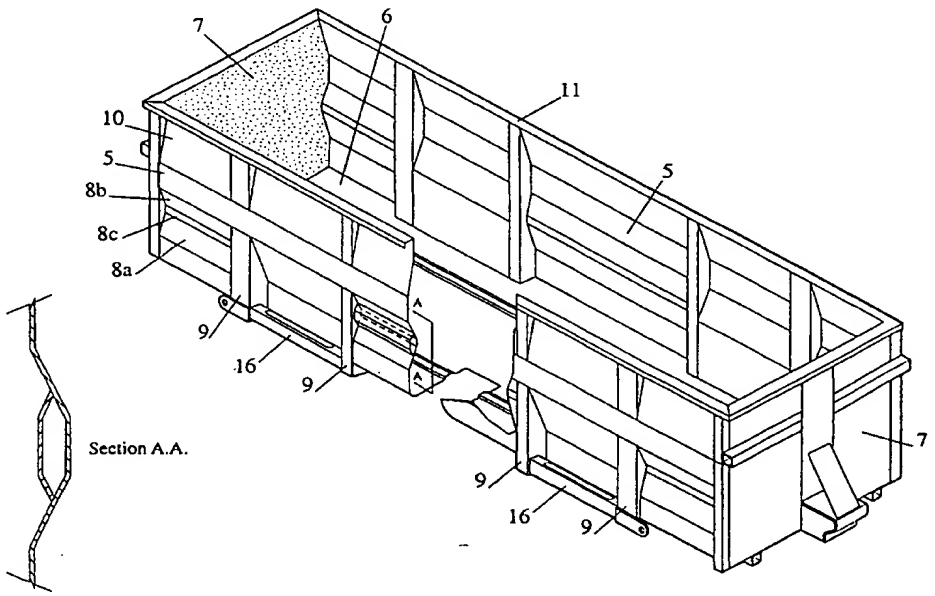

(57) Abstract

Container for transporting bulk material including two side walls (5), two end walls (7) and a base (6); the side walls including a plurality of vertical reinforcing members (9) spaced along the length of the side wall, wherein the side wall between at least one adjacent pair of the reinforcing members includes at least one internal shaped ridge (8) running therebetween. The internal ridge acts as an in-built longitudinal structural stiffener. This container design provides the benefits of being lighter in weight, being cheaper to manufacture, having increased bulk capacity and improved aerodynamics during transportation.

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SIDE REINFORCED BULK MATERIAL TRANSPORT CONTAINER

The present invention is related to bulk transport containers, and in particular to containers used in road and rail transportation.

Bulk transport fleet operators presently use containers that are designed inefficiently and are unable to carry more payload than they are designed for without damaging the container, or without significantly affecting the containers safety and fatigue life. If such containers consistently carry more load than they are designed for, then unexpected structural failures are likely, along with a higher risk of derailment in the case of rail transportation.

The containers presently used by both Australian and international transportation companies to carry bulk product are based on designs that are at least 20 years old. Each new container that is produced is still based on these old concepts, such that the problems inherent in ageing containers will be duplicated in the new containers. Thus, if operators look to maximise the carrying capacity of their containers by increasing payloads the inherent design problems will be exacerbated.

It is an object of the present invention to provide a container for bulk product transportation that is more efficient and cost effective than existing containers.

With the above object in mind the present invention provides a container for transporting bulk material having two side walls, two end walls, and a base; the side walls having a plurality of vertical reinforcing members spaced along the length of the side wall, wherein the side wall between at least one adjacent pair of reinforcing members includes at least one internal ridge running therebetween.

Preferably, there will be at least one internal ridge between each of the reinforcing members.

Preferably, there will be at least one internal ridge between an end wall and a first reinforcing means.

In some instances extra reinforcing members might be required to satisfy the structural strength of any or all panels on the side wall and/or floor and/or end wall.

Ideally, the internal ridge includes a first wall portion angled from the wall towards the interior of the container, and a second wall portion rejoining the first wall portion to the wall. The angle of the first wall portion is in the direction of flow during unloading of the material to be transported.

Alternatively, the internal ridge includes a first wall portion deflected inwardly a progressively increased degree relative to the intersection of the side wall and the base, and a second wall portion extending from the first wall portion and being deflected outwardly a progressively decreased degree relative to the intersection of the side wall and the base.

The angle of the first wall portion may be determined by subtracting the natural angle of repose of the transported product, from the angle the container is rotated during unloading. Whilst the first and second wall portions may be symmetrical, they may also be of uneven length.

In further embodiments, the internal ridge may also include a third wall portion between the first wall portion and the second wall portion. This third wall portion may be flat or concave. Any such flat third wall portion may additionally be parallel to the side wall.

In some applications, a partial internal ridge may extend along the top edge or rim of the side walls. Such a partial internal ridge may consist of the first wall portion of the internal ridge. In this case an additional strengthening member along the edge or rim of the side wall would be included.

In a preferred embodiment, the base of the container also includes at least one internal ridge extending substantially along the length of the base.

It will be convenient to further describe the invention by reference to the accompanying drawings which illustrate possible embodiments of the invention and improvements over the prior art. Other embodiments of the invention are possible and consequently the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the present invention.

Figure 1 shows an isometric view of a conventional container.

Figure 2a shows an isometric view of one container of the present invention.

Figure 2b shows a similar container to that of Figure 2a with a cutaway portion to better show the internal ridge.

Figure 3a shows an isometric view of a further container of the present invention.

Figure 3b shows a similar container to that of Figure 3a with a cutaway portion to better show the internal ridge.

Figure 4a shows a simple cross-sectional view of a conventional container.

Figure 4b shows a simple cross-sectional view of a container of the preferred embodiment of the present invention.

Figure 5 shows a cross-sectional view of a container of the present invention superimposed over a conventional container.

Figure 6 shows the arrangement of the internal ridge for a container with a bottom dumping mechanism.

Figure 7 shows the angle of repose diagrammatically.

Figure 8 shows an expanded view of an internal ridge of the present invention.

Referring now to Figures 1 and 4a, the shape of a conventional container as presently used can be seen. The basic container includes two side walls 1, a base 2, and two end walls 3. The size of any such container, whether it be for transportation by road or by rail, has certain dimensional limitations. That is, neither the height, nor width, of the container can exceed pre-defined dimensions. These pre-defined dimensions are determined by both rail or road standards, and also, the practical limitations of loading and unloading facilities.

Accordingly, whilst it is presently desirable in the industry to increase payloads, the size of the actual containers cannot be increased without decreasing the strength of the containers. In this regard, it is noted that the walls of the containers do not extend to the maximum possible dimensions due to the structural requirements of the container. That is, the bulk product transported via these containers places extreme stresses on the walls of the containers, requiring a number of support or reinforcing members to strengthen the walls. This can conveniently take the form of a number of ribs 4, extending around the

body of the container. The addition of the necessary number of ribs 4 to strengthen the walls 1, result in a much heavier container and in a resultant decrease in the aerodynamics of the container, having both fuel and cost implications on the profitability of the container. It is also noted that structural maintenance and repairs to such containers are both frequent and expensive and do not guarantee that the operational life of the container will be significantly increased.

It will be appreciated that larger containers will require more ribs or reinforcing members. The present invention reduces the number of ribs that is required when compared to a conventional container of equal size.

Referring now to Figures 2, 3 and 4b, the preferred embodiment of the present invention can be seen. The container of the preferred embodiment also includes two side walls 5, two end walls 7, and a base 6. However, the present invention also includes at least one internal ridge 8. The main element of this internal ridge 8, is a first portion 8a, which extends from the wall at an angle towards the interior of the container. A second portion 8b, can be adapted to complete the internal ridge 8, by rejoining the wall 5, to the end of the first portion 8a.

In some circumstances the ridge could be supplemented by extra reinforcing elements to add structural strength if required. That is, dependent on the material to be transported, it may also be desirable to add extra reinforcement to the internal ridge. This extra reinforcement may be added to the internal ridge between each strengthening rib, or alternatively, to the internal ridge in at least one of the wall sections. As seen in Figures 2b and 3b, this reinforcement may be shaped similar to that of the internal ridge.

It is noted that as we move along the first portion 8a from the side wall 5, the angle between the side wall 5 and the position on the first portion 8a relative to the intersection of the side wall 5 and base 6 progressively increases. Similarly, as we return along the second portion 8b, the angle relative to the intersection between the side wall 5 and base 6 progressively decreases.

The angle $\varnothing 1$ at which the portion 8a, extends from the wall 5 towards the interior of the container is chosen to ensure that the product to be carried by

the container is unloaded completely. That is, the angle is preferably dependent on the type of product carried and on the method the operator uses to unload the product. The dimensions of the internal ridge 8, are further determined as a function of the structural strength required and of the natural angle of repose of the material that is to be transported.

The angle at which the first portion 8a extends towards the interior of the container may preferably be determined by the following mathematical formula:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - 90$$

where

$\varnothing 1$–is the angle between the vertical wall 5, and the first portion 8a.

$\varnothing 2$–is the angle the container is rotated in the unloading facility.

$\varnothing 3$– is the natural angle of repose for the product to be transported.

As seen in Figure 7, the natural angle of repose 13 is dependent on the product 12 desired to be carried, and can be determined by pouring or dropping the material 12 on to a level plain so as to form a substantially conical hill. The angle of repose 13 is then determined as the angle between the horizontal plain 15, and a line extending from the base of the cone to the top of the hill.

In some circumstances, it may be more appropriate to use the following formula:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - \varnothing 4 - 90$$

where

$\varnothing 4$–is the cohesion of the material to be transported when wet.

For a bottom dumping container 180° has to be added to the volume for $\varnothing 1$. Alternatively, the formula may be amended by changing the -90° to +90°. In a further alternative $\varnothing 2$ for a bottom dumping container may be considered to be 180°.

Essentially, the shape of the first portion 8a of the internal ridge 8 can be determined on the basis of the natural angle of repose 13 of the material which is to be carried. The second portion 8b will depend on the structural and manufacturing requirements of the container and may be derived from detailed structural analysis of the structural strength and stiffness requirements of the

container. Whilst the second portion 8b may have a similar angle and length to the first portion 8a, this is not a requirement of the internal ridge. That is, the second portion 8b may be shaped differently to the first portion 8a, in that it may be curved, or flat. Alternatively, the length of the second portion 8b may be different to that of the first portion 8a, and accordingly the angle of the second portion 8b between the wall 5 and the second portion 8b will be different. The shape of the second portion 8b of the internal ridge 8 will depend on the limitations, such as space constraints, of the container, and on the number of internal ridges 8 in the wall 5, and to some degree on manufacturing facilities. Whereas the first portion 8a is based on the angle of repose 13 as discussed above, the second and possibly third portions 8b, 8c are chosen to complete the internal ridge 8, and fulfil the structural requirements of the container.

The length and shape of the internal ridge 8, will depend on the structural requirements of the side walls 5 and the base 6. It will also depend on the spacing between supporting frame members 9, and the natural angle of repose of the material. As the distance or spacing between the supporting frame members 9 increases, it will be necessary to increase the depth 16 of the internal ridge 8, to ensure the necessary structural strength. Accordingly, it is possible to design a container specifically for a certain type of material to be transported, by considering the mass of the material and the pressure the material will place on the walls of the container.

A container constructed with an internal ridge of the present invention provides a container that is able to transport bulk product. Furthermore, the internal ridge acts as an in-built longitudinal structural stiffener. This internal ridge, then ensures that the structural requirements, such as strength, fatigue resistance, and buckling capacity, are met, while ensuring that more product can be loaded into a container that has the same exterior dimensions as a conventionally designed container. This difference in carrying capacity can be seen in Figure 5, where the shape of a new container of the present invention is superimposed over a conventional container. The shaded area of Figure 5 shows the extra volume that may be loaded into the new container of the present invention.

The internal ridge 8 is designed to run along the length of the side wall 5 between the supporting frame members 9. Depending on the requirements of the container, for example the placement of locking members 16, the shape and design of the internal ridges 8 may vary between the supporting frame members 9, as seen in Figure 2a. Alternatively, as shown in Figure 3a the internal ridge 8 may be consistent in each panel of the side wall 5.

As can be seen from the figures, it is also preferable to include a partial internal ridge 10 at the top of the container. This partial internal ridge 10 may be formed by a first portion which extends at an angle towards the interior of the container. That is, the partial internal ridge 10 does not include the second portion of the internal ridge 8. Ideally, such a partial internal ridge 10 would also include an additional strengthening member 11 which forms the rim of the container. This rim 11 effectively compensates for the omission of the second portion of the internal ridge, thereby ensuring that the structural strength is sufficient. It will be understood that finite element analysis or other structural analysis can be used to determine the depth of the internal ridge and the thickness of the material to be used for the side wall of the container. Again the depth may be calculated depending on the spacing of the supporting frame members 9, and on the pressure exerted by the material to be carried. The exact figure is derived by applying strength of material theory as well as theories of structural mechanics.

The number and the placement of the internal ridges may be dependent upon the size of the container. As can be seen by a comparison of Figures 1 and 2, the addition of the internal ridge 8 reduces the number of strengthening ribs 4 required on a conventional container. This reduction in the number of ribs decreases the weight of the container, and also improves the aerodynamics of the container. Both these features result in a more cost effective container.

The internal ridge 8 may also include a third portion 8c which joins the first portion 8a to the second portion 8b. This third portion 8c may be used to further improve the structural requirements of the internal ridge 8. Accordingly, depending upon the application, this third portion 8c may be flat or concave. Further, it may run parallel to the wall 5, or extend at some angle relative to the

wall 5. Generally, the longer the third portion 8c is, the stronger the internal ridge 8 is. However, if the third portion 8c is longer then the first portion 8a then some structural strength is lost, and accordingly it is desirable that the third portion 8c not exceed the length of the first portion 8a. Whether a third portion 8c is adopted will again depend on the required strength of the structure as well as any space constraints on the container.

The container of the present invention may be used for bulk transportation by either road or rail. It may also be adapted to be used on containers designed for rotary dumping or tipping, or for bottom dumping. The orientation of the internal ridge will depend upon this unloading method. That is, the first portion 8a is always aligned with the flow of the product being unloaded so as to ensure that no product gets caught up inside the container. If the angle of the internal ridge is not designed so as to ensure that all the product was unloaded, it would be possible for trapped product to unbalance a container thought to be unloaded, thereby possibly causing derailment or collapsing of the container. It will also be understood that the base 6 of the container may also include at least one internal ridge, thereby strengthening the base of the container. The internal ridges running along the base of the container, may go over the wheels and extend through substantially the entire length of the container. Such floor ridges can be constructed having two main functions. One being operational, to bridge over the wheel thereby adding greater interior volume, and secondly structural as the ridge is again designed to provide structural strength. The parameters of the floor ridge are established using structural analysis. The height of the floor ridge is a function of the depth of the container, of the material properties of the product carried, and of the size of the wheels. The dimensions of the floor ridge will also depend on the spacing of the supporting members.

By the addition of at least one internal ridge in the wall of the container, the present invention results in a container that is lighter than conventional containers as the side wall containing the internal ridge does not require as many structural reinforcements as conventional containers, since the internal ridge itself adds to the structural strength of the wall. Again this can be seen by

comparison of Figures 1 and 2, whereby the number of ribs or strengthening elements is less than in the original design. The decrease in the number of ribs 9 also leads to a cheaper container. The decrease in the number of vertical elements, and protruding parts generally improves the aerodynamic shape of the container, thereby making a more efficient and economical container. Further, because fewer welds are required the design ensures that there are fewer areas of stress concentration, thereby making the improved container more fatigue resistant.

As an example of the present invention, for a container designed to carry bulk ore from Mt Whaleback in Western Australia, the overall dimensions of the container could be:

Length = 9.068 metres

Breadth = 3.200 metres

Depth = 2.278 metres

As to the ridge, assuming that the iron ore has a bulk density of 27.1 KN/m^3, an angle of repose of 35° and a side rotation of 137° for unloading, then the internal ridge characteristics could be as follows:

Ø1, the angle between the vertical wall 5 and the first portion of the ridge 8a, is calculated at 12°. Structural analysis has determined that the first internal ridge portion 8a ideally starts at a vertical height of 350mm from the base; is angled inwards at 10 degrees (which is less that the calculated 12° to account for any adhesion of the material) and continues inwards until it reaches a vertical height of 800mm from the base, which is equivalent to a 75mm internal ridge depth. A third portion 8c is required of 95mm vertical height and the second portion 8b joins the third portion 8c, to the vertical wall 5, finishing at an overall height of the completed ridge 1040mm from the base.

Ideally, in the longest wall section an extra reinforcing member would also be added to the internal ridge to provide structural strength.

The main benefits of this design compared to existing bulk iron ore containers carrying the same stated ore are that the overall weight of the container is reduced by approximately 18% due to the improved structural efficiencies gained from the new structural wall and floor shape. Further, the

payload of the improved container is increased by approximately l% over that of a conventional container due to the increase in the container volume.

In addition, the aerodynamic characteristics of the shape reduce the drag coefficient on the side walls by 19% which will result in improved fuel economy for the operator.

In summary, the present invention provides a container that fits into the prescribed parameters, such as the maximum dimensional requirements, but still allows for an increased payload capacity without sacrificing structural strength. The more efficient structural design means that the container is lighter and more aerodynamic. Furthermore, the shape of the container is such that the product unloads easily and no product is left in the container after unloading operations. The angle and shape of the side walls and internal ridge are designed to take into consideration the products natural repose angle as well as the operators loading methodology, thereby ensuring that efficient unloading is achieved.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A container for transporting bulk material including two side walls, two end walls and a base, wherein at least one said side wall includes at least one ridge running the length of said at least one side wall.

2. A container for transporting bulk material including two side walls, two end walls, and a base; said side walls including a plurality of vertical reinforcing members spaced along the length of said side wall, wherein said side wall between at least one adjacent pair of said reinforcing members includes at least one internal ridge running therebetween.

3. A container as claimed in claim 2 further including at least one internal ridge between each of said reinforcing members.

4. A container as claimed in claim 2 or 3 including additional reinforcement running along said internal ridge between each of said reinforcing members.

5. A container as claimed in any one of claims 2 to 4, further including at least one internal ridge between one said end wall and a first reinforcing means.

6. A container as claimed in any preceding claim wherein said ridge includes a first wall portion angled from said wall towards the interior of said container, and a second wall portion rejoining said first wall portion to said wall.

7. A container as claimed in claim 6 wherein the angle of said first wall portion is in the direction of flow during unloading of the material to be transported.

8. A container as claimed in any one of claims 1 to 5, wherein said internal ridge includes a first wall portion deflected inwardly a progressively increased degree relative to the intersection of said side wall and said base, and a second wall portion extending from said first wall portion and being deflected outwardly

a progressively decreased degree relative to the intersection of said side wall and said base.

9. A container as claimed in any one of claims 1 to 8 wherein the angle of said first wall portion is given by:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - 90$$

where:

$\varnothing 1$ - is the angle between said side wall and said first wall portion,

$\varnothing 2$ - is the angle said container is rotated during unloading of said container, and

$\varnothing 3$ - is the natural angle of repose of material to be transported in said container.

10. A container as claimed in any one of claims 1 to 8 wherein the angle of said first wall portion is given by:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - \varnothing 4 - 90$$

where:

$\varnothing 1$ - is the angle between said side wall and said first wall portion,

$\varnothing 2$ - is the angle said container is rotated during unloading of said container,

$\varnothing 3$ - is the natural angle of repose of material to be transported in said container, and

$\varnothing 4$ - is the cohesion of said material to be transported when wet.

11. A container as claimed in any preceding claim wherein said first and second wall portions are symmetrical.

12. A container as claimed in any preceding claim wherein said second wall portion is convex or concave.

13. A container as claimed in any preceding claim wherein said first wall portion is aligned with the flow of material during unloading of said container.

14. A container as claimed in any preceding claim wherein said ridge further includes a third wall portion between said first wall portion and said second wall portion.

15. A container as claimed in claim 14 wherein said third wall portion is concave.

16. A container as claimed in claim 14 wherein said third wall portion is flat or straight.

17. A container as claimed in claim 16 wherein said third wall portion is parallel to said side wall.

18. A container as claimed in claim 16 wherein said third wall portion is angled relative to said side wall.

19. A container as claimed in any one of claims 12 to 18 wherein said first wall portion is equal to or longer than said third wall portion.

20. A container as claimed in any preceding claim wherein at least one said side wall further includes a partial ridge along the top or rim of said at least one side wall, said partial ridge being formed by a fourth wall portion, said fourth wall portion being equivalent to said first wall portion.

21. A container as claimed in claim 20 wherein said partial ridge further includes a strengthening member along the periphery of said fourth wall portion, said strengthening member forming the rim of said container.

22. A container as claimed in any preceding claim wherein said base of said container includes at least one ridge extending substantially along the length of said base.

23. A container as claimed in claim 22 wherein said at least one ridge along said base is located about wheel or track positions of a support for said container.

24. A container substantially as hereinbefore described with reference to figures 2a, 2b, 3a, 3b, 4b, 6 or 8.

25. A container as claimed in any preceding claim for use in transportation of bulk material by road.

26. A container as claimed in any preceding claim for use in transportation of bulk material by rail.

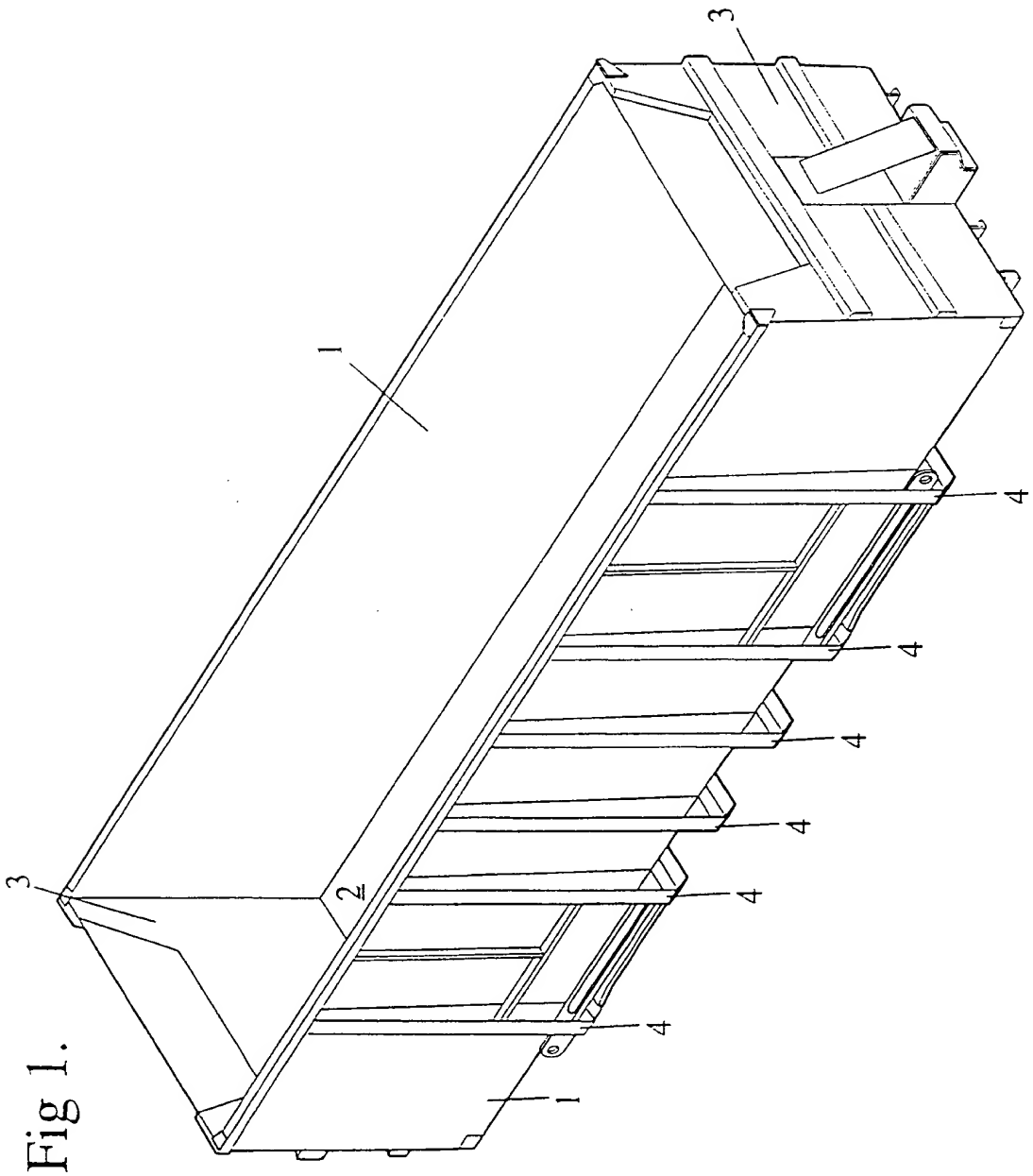


Fig 1.

Fig 2a.

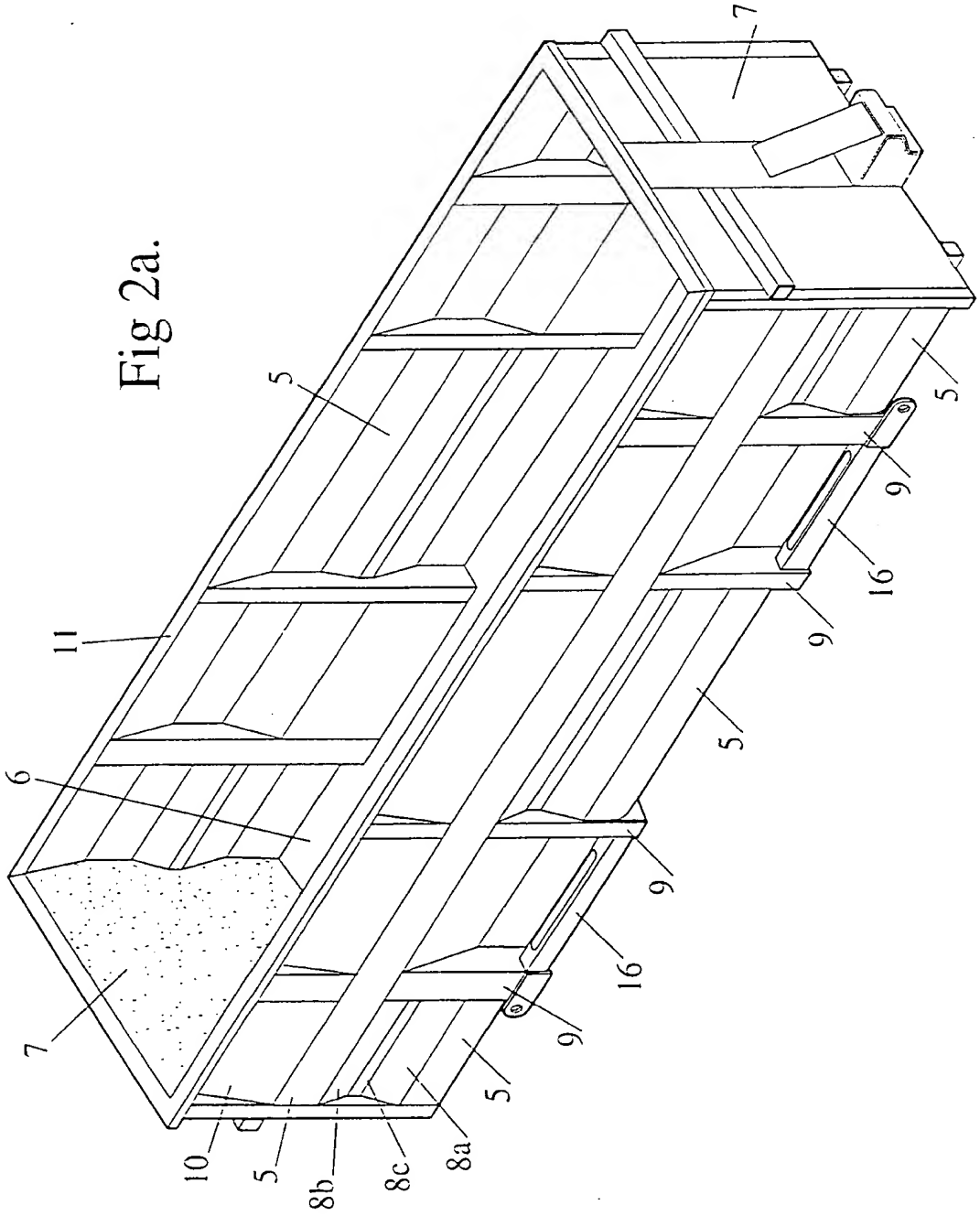


Fig 2b.

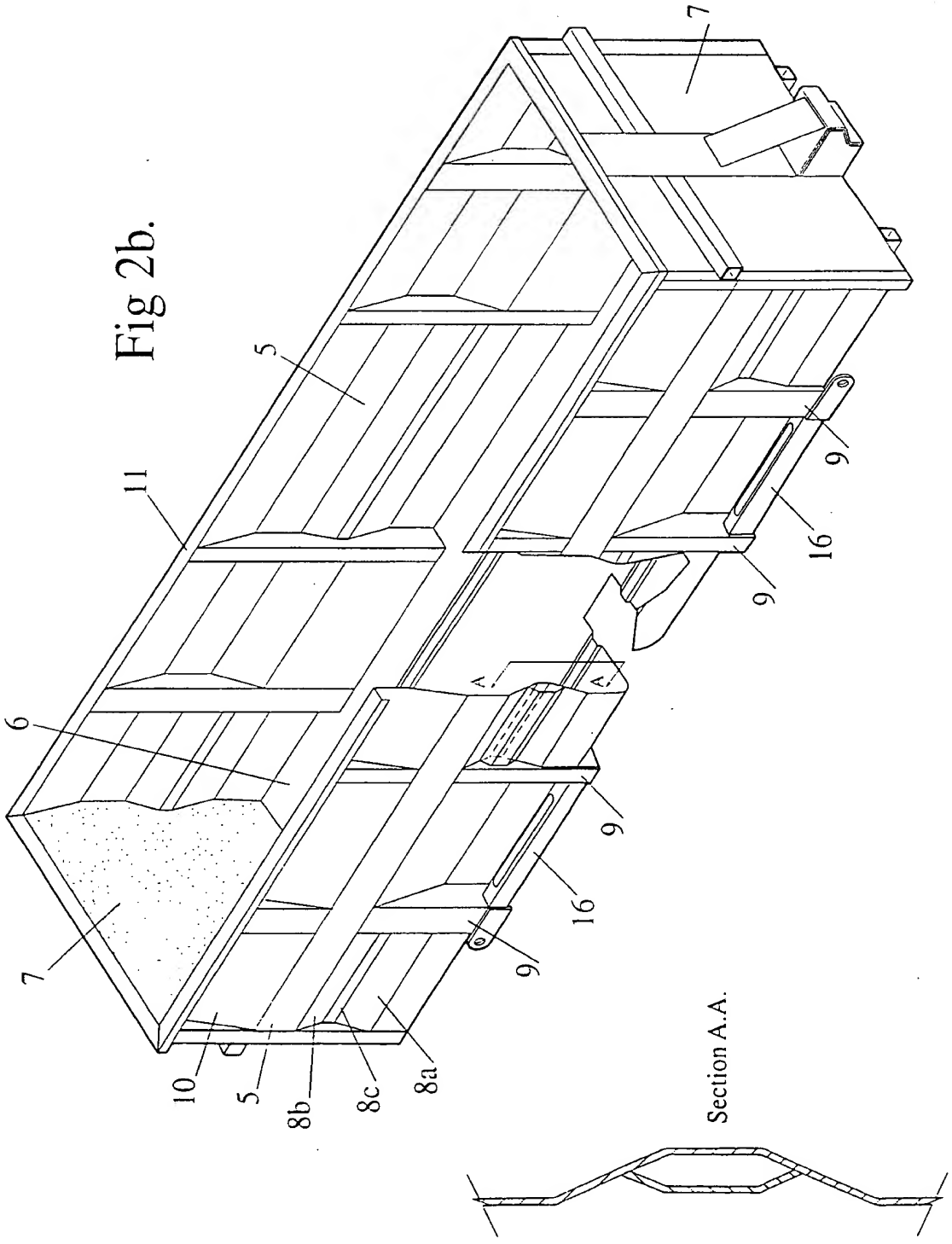


Fig 3a.

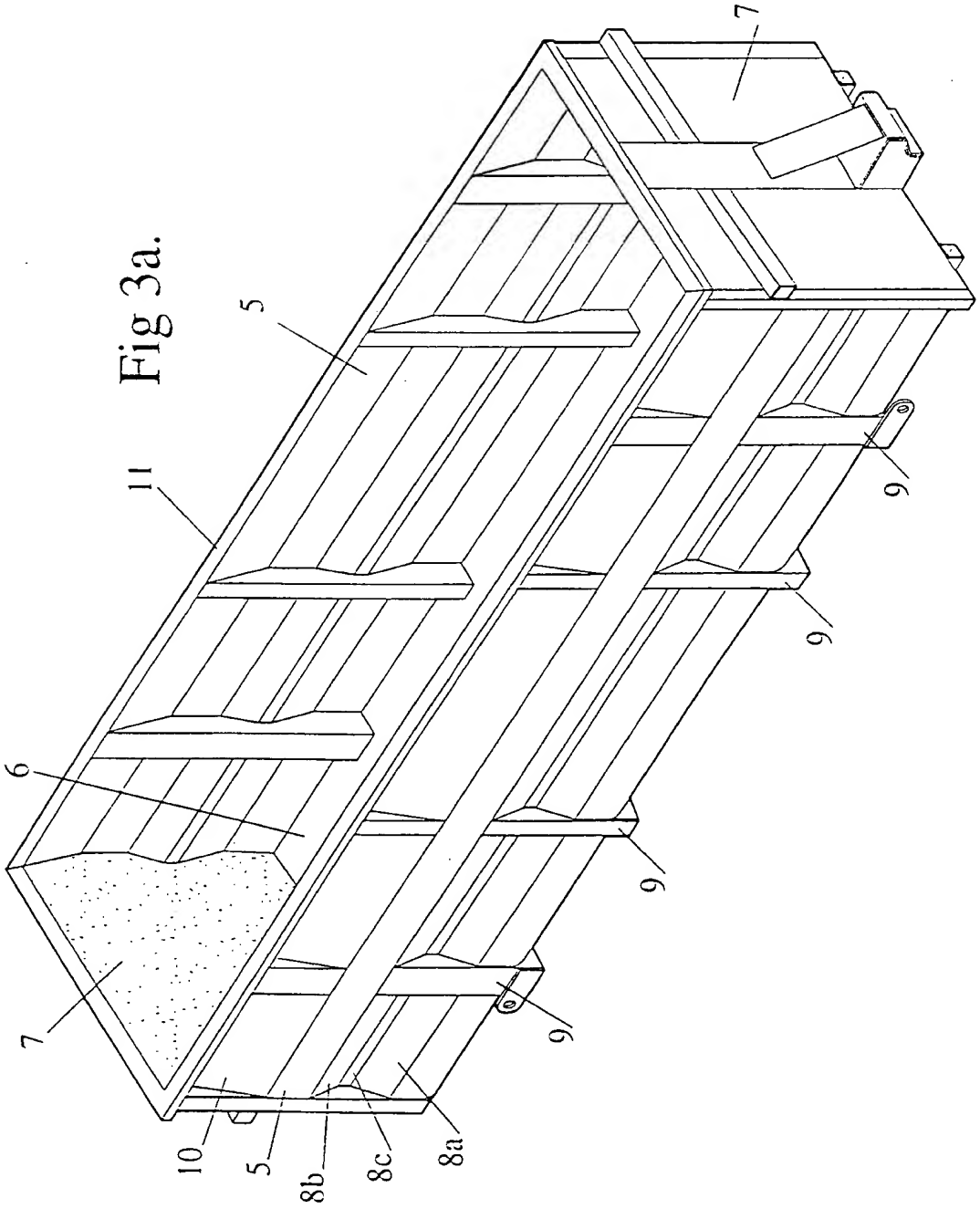


Fig 3b.

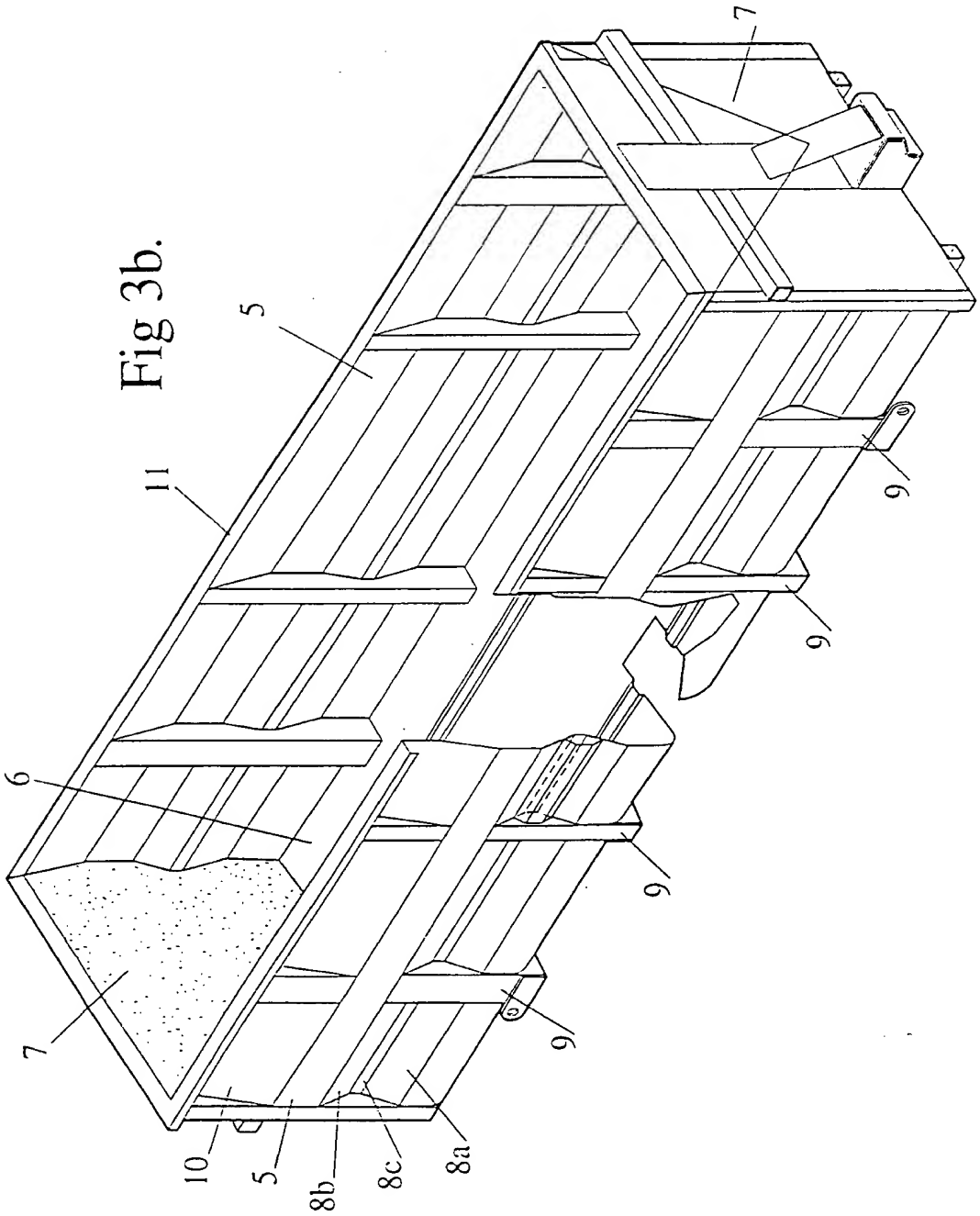


Fig 4a.

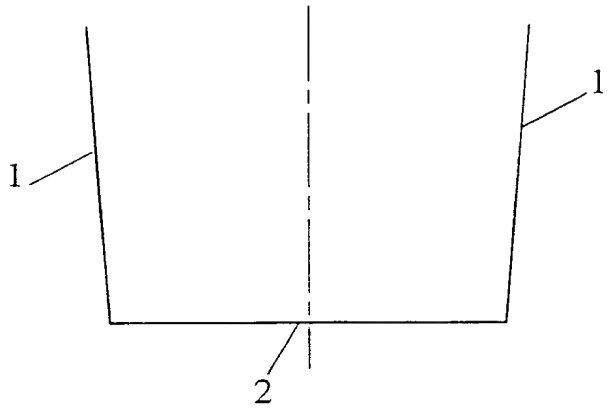


Fig 4b.

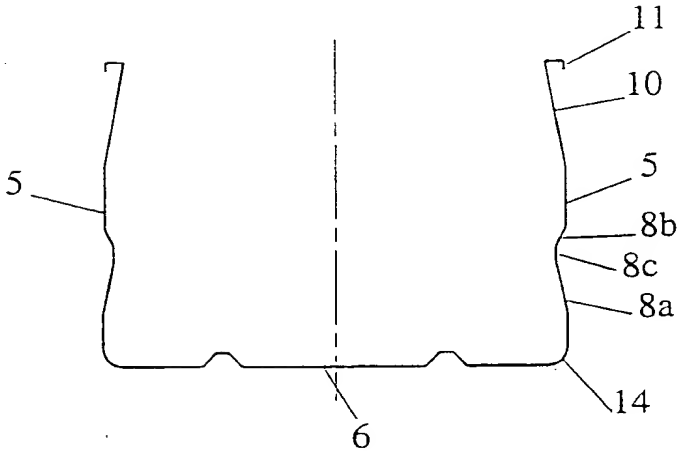


Fig 5.

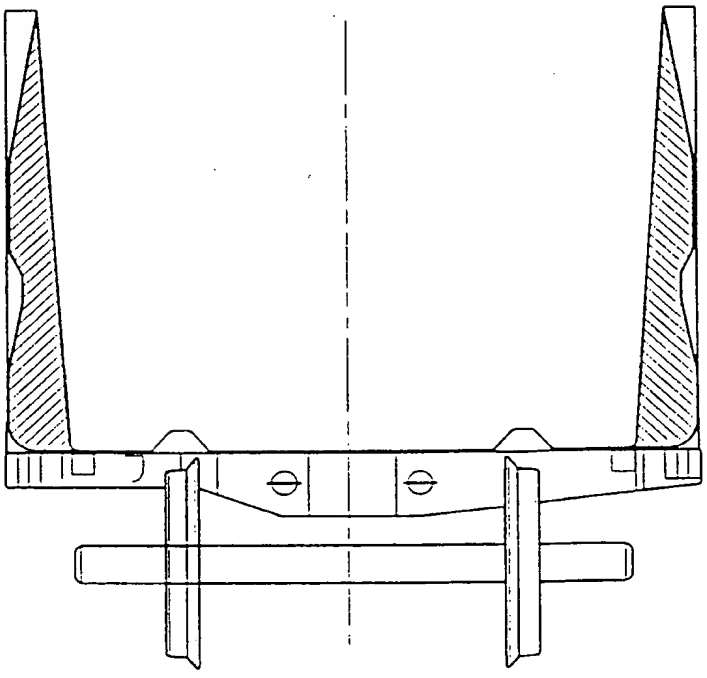


Fig 6.

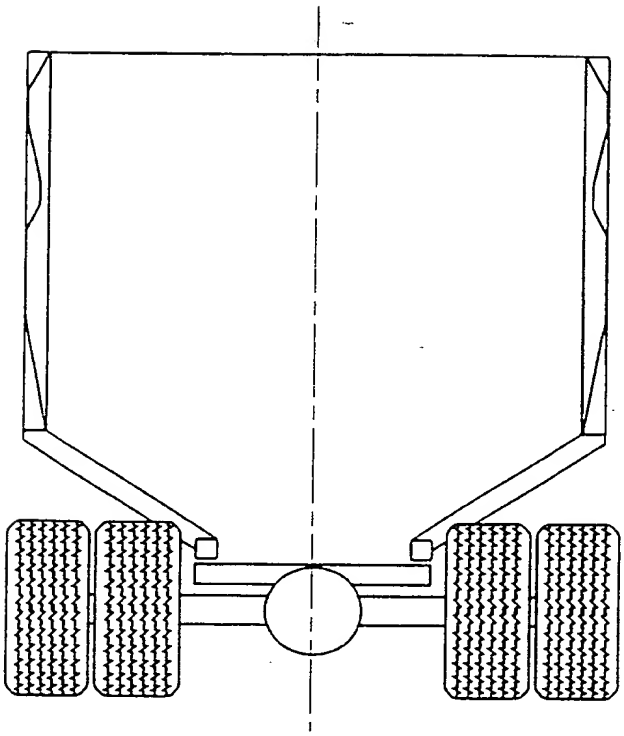


Fig 7.

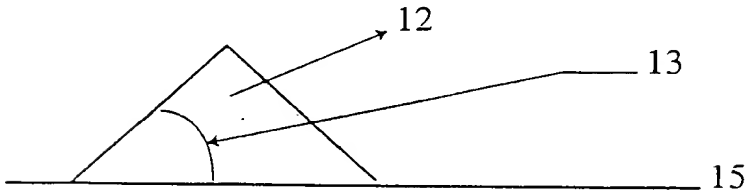
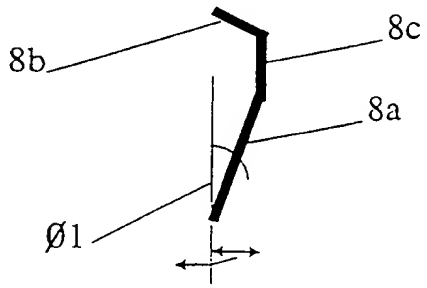


Fig 8.



INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00237

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B65D 88/10, 88/12, 90/02, B61D 17/08, B62D 35/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC : B65D 88/10, 88/12, 90/02, B61D 7/00, 9/06, 11/02, 17/08, B62D 33/04, 35/00, 39/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 83/01930 A (ACF INDUSTRIES INCORPORATED) 9 June 1983 page 7, lines 11-39; and figures	1, 2, 20-26
X	US 4800820 A (TOMAKA) 31 January 1989 whole document; column 4, lines 28-64	1-5, 20-26
X	CA 2185193 A (JOHNSTOWN AMERICA CORP) 4 December 1997 (and US 5860366 A (LYDIC) 19 June 1999; column 3, line 54 to column 4, line 18; and figures)	1, 6-26

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 May 1999	-1 JUN 1999
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929	Authorized officer **ADRIANO GIACOBETTI** Telephone No.: (02) 6283 2579

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 99/00237

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	Derwent Abstract Accession No. 98-558057/48, class Q21, CA 2201041 A (CANADIAN METAL ROLLING MILLS DIV ROLL FO) 13 June 1998 abstract only	1

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU 99/00237

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
WO	83/01930	AU	10462/83	CA	1199526	EP	96692
		IT	1198417	US	4608931	ZA	8208479
US	4800820	CA	1235951				
US	5860366	CA	2185193				

END OF ANNEX

17

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P15753PC00 PVF:JAM	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International application No. **PCT/AU 99/00237**	International filing date *(day/month/year)* 30 March 1999	Priority Date *(day/month/year)* 30 March 1998

International Patent Classification (IPC) or national classification and IPC

Int. Cl.[7] B65D 88/10, 88/12, 90/02, B61D 17/08, B62D 35/00

Applicant

LYNX ENGINEERING CONSULTANTS PTY LTD et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of **13** sheet(s).

3. This report contains indications relating to the following items:

I	[X]	Basis of the report
II	[ ]	Priority
III	[ ]	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[X]	Certain documents cited
VII	[X]	Certain defects in the international application
VIII	[ ]	Certain observations on the international application

Date of submission of the demand	Date of completion of the report
5 October 1999	17 February 2000
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer **ADRIANO GIACOBETTI** Telephone No. (02) 6283 2579

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU 99/00237

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description, pages **2-4** as originally filed,
pages , filed with the demand,
pages **1, 5-10** filed with the letter of **14 December 1999**.

☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages **12-15** filed with the letter of **14 December 1999,**
pages **11** filed with the letter of **9 February 2000**.

☒ the drawings, pages **1/7-7/7** as originally filed,
pages , filed with the demand,
pages , filed with the letter of .

☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , filed with the letter of .

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, was on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages

☐ the claims, Nos.

☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims 1-31	YES
	Claims	NO
Inventive step (IS)	Claims 1-31	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-31	YES
	Claims	NO

2. Citations and explanations (Rule 70.7)

Cited Prior Art Documents

(D1) WO 83/01930 A (ACF INDUSTRIES INCORPORATED)
(D2) US 4800820 A (TOMAKA)
(D3) US 5860366 A (LYDIC)
(Note: Document (D3) is a family equivalent of CA 2185193 A (JOHNSTOWN AMERICA CORP) 4 December 1997)

NOVELTY(N) and INVENTIVE STEP(IS): Claims 1-31

Documents (D1) to (D3) each disclose a hopper container car for transporting bulk material having two side walls, two end walls and a base. The container cars are provided with at least one longitudinal ridge extending along a side wall and between the end walls. Document (D3) discloses that the longitudinal ridge is positioned within the interior of the container and thus alters the interior body shape as shown in figure 10 and described in column 3, line 54 to column 4, line 18.

The present invention of new independent claims 1 and 2 defines a container for transporting bulk material having at least one internal ridge running along at least one side wall and the ridge is integrally formed within the side wall. This container arrangement of integral ridge(s) allows (a) for thinner material to be used which results in a lighter container, (b) for increased payload of the standard container through full utilisation of the cross section of the container within a given dimensional envelope for rail and road containers, and (c) for reduced number of external ribs.

The above prior art documents do not suggest or fairly teach that the internal ridges are integrally formed as part of the side wall. Hence it would appear that the invention as defined in claims 1-31 is novel and involves an inventive step.

With regard to the document listed in Box VI under "certain documents cited", this document is published prior to the international filing date but later than the priority date claimed but which would otherwise be considered to be of particular relevance.
Under the PCT, novelty is considered only in respect of documents published before the priority date. The relevance of a document published after the priority date is dependent upon national law. Such documents are excluded from consideration in preliminary examination, under the PCT Guidelines but have been included in Box VI for information.

INDUSTRIAL APPLICABILITY(IA): Claims 1-31

The invention as defined in claims 1-31 meet the requirements of industrial applicability under Article 33(4) of the PCT because the invention can be made or used in industry.

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
P,X CA 2201041 A	13 June 1998	26 March 1997	26 March 1997

This document discloses a bulk container rail car with a series of longitudinally extending strengthening ribs (ie ridge) along the length. The strengthening ribs are integrally formed in the side wall of the container. As a result the container has reduced weight, improved appearance and enhanced rigidity which are the objectives of the present invention. Therefore the features of claim 1 are disclosed in this document.

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

1. Independent Claim 29 does not comply with Rule 6.2(a) because this claim relies on reference to figures of the drawings.

BULK MATERIAL TRANSPORT CONTAINERS

The present invention is related to bulk transport containers, and in particular to containers used in road and rail transportation.

Bulk transport fleet operators presently use containers that are designed inefficiently and are unable to carry more payload than they are designed for without damaging the container, or without significantly affecting the containers safety and fatigue life. If such containers consistently carry more load than they are designed for, then unexpected structural failures are likely, along with a higher risk of derailment in the case of rail transportation.

The containers presently used by both Australian and international transportation companies to carry bulk product are based on designs that are at least 20 years old. Each new container that is produced is still based on these old concepts, such that the problems inherent in ageing containers will be duplicated in the new containers. Thus, if operators look to maximise the carrying capacity of their containers by increasing payloads the inherent design problems will be exacerbated.

It is an object of the present invention to provide a container for bulk product transportation that is more efficient and cost effective than existing containers.

With the above object in mind the present invention provides a container for transporting bulk material including two side walls, two end walls and a base, wherein at least one said side wall includes at least one ridge running along said at least one side wall between said end walls, and wherein said ridge is integrally formed within said at least one side wall.

Preferably, there will be at least one internal ridge between each of the reinforcing members.

Preferably, there will be at least one internal ridge between an end wall and a first reinforcing means.

In some instances extra reinforcing members might be required to satisfy the structural strength of any or all panels on the side wall and/or floor and/or end wall.

the container is unloaded completely. That is, the angle is preferably dependent on the type of product carried and on the method the operator uses to unload the product. The dimensions of the internal ridge 8, are further determined as a function of the structural strength required and of the natural angle of repose of the material that is to be transported.

The angle at which the first portion 8a extends towards the interior of the container may preferably be determined by the following mathematical formula:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - 90$$

where

$\varnothing 1$–is the angle between the vertical wall 5, and the first portion 8a.

$\varnothing 2$–is the angle the container is rotated in the unloading facility.

$\varnothing 3$– is the natural angle of repose for the product to be transported.

As seen in Figure 7, the natural angle of repose 13 is dependent on the product 12 desired to be carried, and can be determined by pouring or dropping the material 12 on to a level plain so as to form a substantially conical hill. The angle of repose 13 is then determined as the angle between the horizontal plain 15, and a line extending from the base of the cone to the top of the hill.

In some circumstances, it may be more appropriate to use the following formula:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - \varnothing 4 - 90$$

where

$\varnothing 4$–is the cohesion of the material to be transported when wet.

For a bottom dumping container 180° has to be added to the volume for $\varnothing 1$. Alternatively, the formula may be amended by changing the –90° to +90°. In a further alternative $\varnothing 2$ for a bottom dumping container may be considered to be 180°.

For a bottom dumping container, the ridge can be configured to extend away from the interior of the container. Such an arrangement will not provide the same increased payload as a ridge which extends towards the interior of the container, but nevertheless, will provide substantial gains in cost reduction of fabrication from conventional containers which merely provide an additional

strengthening member along the exterior of a standard container.

Essentially, the shape of the first portion 8a of the internal ridge 8 can be determined on the basis of the natural angle of repose 13 of the material which is to be carried. The second portion 8b will depend on the structural and manufacturing requirements of the container and may be derived from detailed structural analysis of the structural strength and stiffness requirements of the container. Whilst the second portion 8b may have a similar angle and length to the first portion 8a, this is not a requirement of the internal ridge. That is, the second portion 8b may be shaped differently to the first portion 8a, in that it may be curved, or flat. Alternatively, the length of the second portion 8b may be different to that of the first portion 8a, and accordingly the angle of the second portion 8b between the wall 5 and the second portion 8b will be different. The shape of the second portion 8b of the internal ridge 8 will depend on the limitations, such as space constraints, of the container, and on the number of internal ridges 8 in the wall 5, and to some degree on manufacturing facilities. Whereas the first portion 8a is based on the angle of repose 13 as discussed above, the second and possibly third portions 8b, 8c are chosen to complete the internal ridge 8, and fulfil the structural requirements of the container.

The length and shape of the internal ridge 8, will depend on the structural requirements of the side walls 5 and the base 6. It will also depend on the spacing between supporting frame members 9, and the natural angle of repose of the material. As the distance or spacing between the supporting frame members 9 increases, it will be necessary to increase the depth 16 of the internal ridge 8, to ensure the necessary structural strength. Accordingly, it is possible to design a container specifically for a certain type of material to be transported, by considering the mass of the material and the pressure the material will place on the walls of the container.

A container constructed with an internal ridge of the present invention provides a container that is able to transport bulk product. Furthermore, the internal ridge acts as an in-built longitudinal structural stiffener. This internal ridge, then ensures that the structural requirements, such as strength, fatigue resistance, and buckling capacity, are met, while ensuring that more product can be loaded into a container that has the same exterior dimensions as a

conventionally designed container. This difference in carrying capacity can be seen in Figure 5, where the shape of a new container of the present invention is superimposed over a conventional container. The shaded area of Figure 5 shows the extra volume that may be loaded into the new container of the present invention.

The internal ridge 8 is designed to run along the length of the side wall 5 between the supporting frame members 9. Depending on the requirements of the container, for example the placement of locking members 16, the shape and design of the internal ridges 8 may vary between the supporting frame members 9, as seen in Figure 2a. Alternatively, as shown in Figure 3a the internal ridge 8 may be consistent in each panel of the side wall 5.

As can be seen from the figures, it is also preferable to include a partial internal ridge 10 at the top of the container. This partial internal ridge 10 may be formed by a first portion which extends at an angle towards the interior of the container. That is, the partial internal ridge 10 does not include the second portion of the internal ridge 8. Ideally, such a partial internal ridge 10 would also include an additional strengthening member 11 which forms the rim of the container. This rim 11 effectively compensates for the omission of the second portion of the internal ridge, thereby ensuring that the structural strength is sufficient. It will be understood that finite element analysis or other structural analysis can be used to determine the depth of the internal ridge and the thickness of the material to be used for the side wall of the container. Again the depth may be calculated depending on the spacing of the supporting frame members 9, and on the pressure exerted by the material to be carried. The exact figure is derived by applying strength of material theory as well as theories of structural mechanics.

The number and the placement of the internal ridges may be dependent upon the size of the container. As can be seen by a comparison of Figures 1 and 2, the addition of the internal ridge 8 reduces the number of strengthening ribs 4 required on a conventional container. This reduction in the number of ribs decreases the weight of the container, and also improves the aerodynamics of the container. Both these features result in a more cost effective container.

The internal ridge 8 may also include a third portion 8c which joins the first

portion 8a to the second portion 8b. This third portion 8c may be used to further improve the structural requirements of the internal ridge 8. Accordingly, depending upon the application, this third portion 8c may be flat or concave. Further, it may run parallel to the wall 5, or extend at some angle relative to the wall 5. Generally, the longer the third portion 8c is, the stronger the internal ridge 8 is. However, if the third portion 8c is longer then the first portion 8a then some structural strength is lost, and accordingly it is desirable that the third portion 8c not exceed the length of the first portion 8a. Whether a third portion 8c is adopted will again depend on the required strength of the structure as well as any space constraints on the container.

The container of the present invention may be used for bulk transportation by either road or rail. It may also be adapted to be used on containers designed for rotary dumping or tipping, or for bottom dumping. The orientation of the internal ridge will depend upon this unloading method. That is, the first portion 8a is always aligned with the flow of the product being unloaded so as to ensure that no product gets caught up inside the container. If the angle of the internal ridge is not designed so as to ensure that all the product was unloaded, it would be possible for trapped product to unbalance a container thought to be unloaded, thereby possibly causing derailment or collapsing of the container. It will also be understood that the base 6 of the container may also include at least one internal ridge, thereby strengthening the base of the container. The internal ridges running along the base of the container, may go over the wheels and extend through substantially the entire length of the container. Such floor ridges can be constructed having two main functions. One being operational, to bridge over the wheel thereby adding greater interior volume, and secondly structural as the ridge is again designed to provide structural strength. The parameters of the floor ridge are established using structural analysis. The height of the floor ridge is a function of the depth of the container, of the material properties of the product carried, and of the size of the wheels. The dimensions of the floor ridge will also depend on the spacing of the supporting members.

By the addition of at least one internal ridge in the wall of the container, the present invention results in a container that is lighter than conventional containers as the side wall containing the internal ridge does not require as many structural

reinforcements as conventional containers, since the internal ridge itself adds to the structural strength of the wall. Again this can be seen by comparison of Figures 1 and 2, whereby the number of ribs or strengthening elements is less than in the original design. The decrease in the number of ribs 9 also leads to a cheaper container. The decrease in the number of vertical elements, and protruding parts generally improves the aerodynamic shape of the container, thereby making a more efficient and economical container. Further, because fewer welds are required the design ensures that there are fewer areas of stress concentration, thereby making the improved container more fatigue resistant.

As an example of the present invention, for a container designed to carry bulk ore from Mt Whaleback in Western Australia, the overall dimensions of the container could be:

Length = 9.068 metres

Breadth = 3.200 metres

Depth = 2.278 metres

As to the ridge, assuming that the iron ore has a bulk density of 27.1 KN/m^3, an angle of repose of 35° and a side rotation of 137° for unloading, then the internal ridge characteristics could be as follows:

∅1, the angle between the vertical wall 5 and the first portion of the ridge 8a, is calculated at 12°. Structural analysis has determined that the first internal ridge portion 8a ideally starts at a vertical height of 350mm from the base; is angled inwards at 10 degrees (which is less that the calculated 12° to account for any adhesion of the material) and continues inwards until it reaches a vertical height of 800mm from the base, which is equivalent to a 75mm internal ridge depth. A third portion 8c is required of 95mm vertical height and the second portion 8b joins the third portion 8c, to the vertical wall 5, finishing at an overall height of the completed ridge 1040mm from the base.

Ideally, in the longest wall section an extra reinforcing member would also be added to the internal ridge to provide structural strength.

The main benefits of this design compared to existing bulk iron ore containers carrying the same stated ore are that the overall weight of the container is reduced by approximately 18% due to the improved structural efficiencies gained from the new structural wall and floor shape. Further, the

payload of the improved container is increased by approximately l% over that of a conventional container due to the increase in the container volume.

In addition, the aerodynamic characteristics of the shape reduce the drag coefficient on the side walls by 19% which will result in improved fuel economy for the operator.

In summary, the present invention provides a container that fits into the prescribed parameters, such as the maximum dimensional requirements, but still allows for an increased payload capacity without sacrificing structural strength. The more efficient structural design means that the container is lighter and more aerodynamic. Furthermore, the shape of the container is such that the product unloads easily and no product is left in the container after unloading operations. The angle and shape of the side walls and internal ridge are designed to take into consideration the products natural repose angle as well as the operators loading methodology, thereby ensuring that efficient unloading is achieved.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A container for transporting bulk material including two side walls, two end walls and a base, wherein at least one said side wall includes at least one internal ridge running along said at least one side wall between said end walls, and wherein said ridge is integrally formed within said at least one side wall.

2. A container for transporting bulk material including two side walls, two end walls, and a base; said side walls including a plurality of vertical reinforcing members spaced along the length of said side wall, wherein said side wall between at least one adjacent pair of said reinforcing members includes at least one internal ridge running therebetween, wherein said ridge is integrally formed within said side wall.

3. A container as claimed in claim 2 further including at least one internal ridge between each of said reinforcing members.

4. A container as claimed in claim 2 or 3 including additional reinforcement aligned along said internal ridge between each of said reinforcing members.

5. A container as claimed in any one of claims 2 to 4, further including at least one internal ridge between one said end wall and a first reinforcing member.

6. A container as claimed in any preceding claim wherein said ridge includes a first wall portion angled from said wall towards the interior of said container, and a second wall portion rejoining said first wall portion to said wall.

7. A container as claimed in any one of claims 1 to 5, adapted for unloading of material through the base of the container, wherein said ridge includes a first wall portion angled from said wall away from the interior of said container, and a second wall portion rejoining said first wall portion to said wall.

8. A container as claimed in claim 6 or claim 7 wherein the angle of said first

wall portion is in the direction of flow during unloading of the material to be transported.

9. A container as claimed in any one of claims 1 to 5, wherein said internal ridge includes a first wall portion deflected inwardly a progressively increased degree relative to the intersection of said side wall and said base, and a second wall portion extending from said first wall portion and being deflected outwardly a progressively decreased degree relative to the intersection of said side wall and said base.

10. A container as claimed in any one of claims 1 to 9 wherein said first wall portion extends from said side wall at an angle Ø1, wherein:

$$Ø1 \leq Ø2 - Ø3 - 90°$$

where:

Ø1 - is the angle between said side wall and said first wall portion,

Ø2 - is the angle said container is rotated during unloading of said container, and

Ø3 - is the natural angle of repose of material to be transported in said container.

11. A container as claimed in any one of claims 1 to 9 wherein said first wall portion extends from said side wall at an angle Ø1, wherein:

$$Ø1 \leq Ø2 - Ø3 - Ø4 - 90°$$

where:

Ø1 - is the angle between said side wall and said first wall portion,

Ø2 - is the angle said container is rotated during unloading of said container,

Ø3 - is the natural angle of repose of material to be transported in said container, and

Ø4 - is the cohesion of said material to be transported when wet.

12. A container as claimed in any one of claims 1 to 9 adapted for unloading of material through the base of the container, and wherein said first wall portion extends from said side wall at an angle Ø1, wherein:

$$Ø1 \leq 90° - Ø3$$

where:

Ø1 - is the angle between said side wall and said first wall portion, and

Ø3 - is the natural angle of repose of material to be transported in said container.

13. A container as claimed in any one of claims 1 to 9 adapted for unloading of material through the base of the container, and wherein said first wall portion extends from said side wall at an angle Ø1, wherein:

$$Ø1 \leq 90° - Ø3 - Ø4$$

where:

Ø1 - is the angle between said side wall and said first wall portion,

Ø3 - is the natural angle of repose of material to be transported in said container, and

Ø4 - is the cohesion of said material to be transported when wet.

14. A container as claimed in any preceding claim wherein said first and second wall portions are symmetrical.

15. A container as claimed in any preceding claim wherein said second wall portion is convex or concave.

16 A container as claimed in one of claims 6 to 15, wherein said first wall portion is aligned with the flow of material during unloading of said container.

17. A container as claimed in any one of claims 6 to 16, wherein said ridge further includes a third wall portion between said first wall portion and said second wall portion.

18. A container as claimed in claim 17 wherein said third wall portion is concave.

19.. A container as claimed in claim 17 wherein said third wall portion is flat or straight.

20. A container as claimed in claim 19 wherein said third wall portion is parallel to said side wall.

21. A container as claimed in claim 19 wherein said third wall portion is angled relative to said side wall.

22. A container as claimed in any one of claims 17 to 21 wherein said first wall portion is equal to or longer than said third wall portion.

23. A container as claimed in any one of claims 6 to 22, wherein at least one said side wall further includes a partial ridge along the top or rim of said at least one side wall, said partial ridge being formed by a fourth wall portion, said fourth wall portion being equivalent to said first wall portion.

24. A container as claimed in claim 23, wherein said fourth wall portion is of equal length to said first wall portion.

25. A container as claimed in claim 23 or 24 wherein said partial ridge further includes a strengthening member along the periphery of said fourth wall portion, said strengthening member forming the rim of said container.

26. A container as claimed in claim 25, wherein said strengthening member is integrally formed within said at least one side wall.

27. A container as claimed in any preceding claim wherein said base of said container includes at least one ridge extending substantially along the length of said base.

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28. A container as claimed in claim 27 wherein said at least one ridge along said base is located about wheel or track positions of a support for said container.

29. A container substantially as hereinbefore described with reference to figures 2a, 2b, 3a, 3b, 4b, 6 or 8.

30. A container as claimed in any preceding claim for use in transportation of bulk material by road.

31. A container as claimed in any preceding claim for use in transportation of bulk material by rail.

ABSTRACT

A container for transporting bulk material including two side walls, two end walls, and a base; the side walls including a plurality of vertical reinforcing members spaced along the length of the side wall, wherein the side wall between at least one adjacent pair of the reinforcing members includes at least one internal ridge running therebetween.

PATENT COOPERATION TREATY

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:

Watermark Patent & Trademark Attorneys
4th Floor, Durack Centre
263 Adelaide Terrace
PERTH WA 6000

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of mailing *day/month/year* 02 MAR 2000

Applicant's or agent's file reference
P15753PC00 PVF:JAM

IMPORTANT NOTIFICATION

International application No.	International filing date	Priority date
PCT/AU 99/00237	30 March 1999	30 March 1998

Applicant
LYNX ENGINEERING CONSULTANTS PTY LTD et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translations to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide

Name and mailing address of the IPEA/AU

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P15753PC00 PVF:JAM	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International application No. PCT/AU 99/00237	International filing date *(day/month/year)* 30 March 1999	Priority Date *(day/month/year)* 30 March 1998
International Patent Classification (IPC) or national classification and IPC **Int. Cl.**[7] B65D 88/10, 88/12, 90/02, B61D 17/08, B62D 35/00		
Applicant LYNX ENGINEERING CONSULTANTS PTY LTD et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   [X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of **13** sheet(s).

3. This report contains indications relating to the following items:

I	[X]	Basis of the report
II	[ ]	Priority
III	[ ]	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[X]	Certain documents cited
VII	[X]	Certain defects in the international application
VIII	[ ]	Certain observations on the international application

Date of submission of the demand 5 October 1999	Date of completion of the report 17 February 2000
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer ADRIANO GIACOBETTI Telephone No. (02) 6283 2579

INTERNATIONAL PRELI[redacted]RY EXAMINATION REPORT

[redacted]rnational application No.
PCT/AU 99/00237

I. Basis of the report

1. With regard to the elements of the international application:*

☐ the international application as originally filed.

☒ the description, pages 2-4 as originally filed,
pages , filed with the demand,
pages 1, 5-10 filed with the letter of 14 December 1999.

☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages 12-15 filed with the letter of 14 December 1999,
pages 11 filed with the letter of 9 February 2000.

☒ the drawings, pages 1/7-7/7 as originally filed,
pages , filed with the demand,
pages , filed with the letter of .

☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , filed with the letter of .

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, was on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages

☐ the claims, Nos.

☐ the drawings, sheets/fig.

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU 99/00237

V. **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims 1-31	YES
	Claims	
Inventive step (IS)	Claims 1-31	NO
	Claims	YES
Industrial applicability (IA)	Claims 1-31	NO
	Claims	YES

2. Citations and explanations (Rule 70.7)

Cited Prior Art Documents

(D1) WO 83/01930 A (ACF INDUSTRIES INCORPORATED)
(D2) US 4800820 A (TOMAKA)
(D3) US 5860366 A (LYDIC)
(Note: Document (D3) is a family equivalent of CA 2185193 A (JOHNSTOWN AMERICA CORP) 4 December 1997)

NOVELTY(N) and INVENTIVE STEP(IS): Claims 1-31

Documents (D1) to (D3) each disclose a hopper container car for transporting bulk material having two side walls, two end walls and a base. The container cars are provided with at least one longitudinal ridge extending along a side wall and between the end walls. Document (D3) discloses that the longitudinal ridge is positioned within the interior of the container and thus alters the interior body shape as shown in figure 10 and described in column 3, line 54 to column 4, line 18.

The present invention of new independent claims 1 and 2 defines a container for transporting bulk material having at least one internal ridge running along at least one side wall and the ridge is integrally formed within the side wall. This container arrangement of integral ridge(s) allows (a) for thinner material to be used which results in a lighter container, (b) for increased payload of the standard container through full utilisation of the cross section of the container within a given dimensional envelope for rail and road containers, and (c) for reduced number of external ribs.

The above prior art documents do not suggest or fairly teach that the internal ridges are integrally formed as part of the side wall. Hence it would appear that the invention as defined in claims 1-31 is novel and involves an inventive step.

With regard to the document listed in Box VI under "certain documents cited", this document is published prior to the international filing date but later than the priority date claimed but which would otherwise be considered to be of particular relevance.
Under the PCT, novelty is considered only in respect of documents published before the priority date. The relevance of a document published after the priority date is dependent upon national law. Such documents are excluded from consideration in preliminary examination, under the PCT Guidelines but have been included in Box VI for information.

INDUSTRIAL APPLICABILITY(IA): Claims 1-31

The invention as defined in claims 1-31 meet the requirements of industrial applicability under Article 33(4) of the PCT because the invention can be made or used in industry.

VI. Certain documents cited

1. Certain published documents (Rule 70.10)

Application No. Patent No.	Publication date *(day/month/year)*	Filing date *(day/month/year)*	Priority date (valid claim) *(day/month/year)*
P,X CA 2201041 A	13 June 1998	26 March 1997	26 March 1997

This document discloses a bulk container rail car with a series of longitudinally extending strengthening ribs (ie ridge) along the length. The strengthening ribs are integrally formed in the side wall of the container. As a result the container has reduced weight, improved appearance and enhanced rigidity which are the objectives of the present invention. Therefore the features of claim 1 are disclosed in this document.

2. Non-written disclosures (Rule 70.9)

Kind of non-written disclosure	Date of non-written disclosure *(day/month/year)*	Date of written disclosure referring to non-written disclosure *(day/month/year)*

International application No.
PCT/AU 99/00237

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

1. Independent Claim 29 does not comply with Rule 6.2(a) because this claim relies on reference to figures of the drawings.

SIDE REINFORCED BULK MATERIAL TRANSPORT CONTAINER

The present invention is related to bulk transport containers, and in particular to containers used in road and rail transportation.

Bulk transport fleet operators presently use containers that are designed inefficiently and are unable to carry more payload than they are designed for without damaging the container, or without significantly affecting the containers safety and fatigue life. If such containers consistently carry more load than they are designed for, then unexpected structural failures are likely, along with a higher risk of derailment in the case of rail transportation.

The containers presently used by both Australian and international transportation companies to carry bulk product are based on designs that are at least 20 years old. Each new container that is produced is still based on these old concepts, such that the problems inherent in ageing containers will be duplicated in the new containers. Thus, if operators look to maximise the carrying capacity of their containers by increasing payloads the inherent design problems will be exacerbated.

It is an object of the present invention to provide a container for bulk product transportation that is more efficient and cost effective than existing containers.

With the above object in mind the present invention provides a container for transporting bulk material having two side walls, two end walls, and a base; the side walls having a plurality of vertical reinforcing members spaced along the length of the side wall, wherein the side wall between at least one adjacent pair of reinforcing members includes at least one internal ridge running therebetween.

Preferably, there will be at least one internal ridge between each of the reinforcing members.

Preferably, there will be at least one internal ridge between an end wall and a first reinforcing means.

In some instances extra reinforcing members might be required to satisfy the structural strength of any or all panels on the side wall and/or floor and/or end wall.

the container is unloaded completely. That is, the angle is preferably dependent on the type of product carried and on the method the operator uses to unload the product. The dimensions of the internal ridge 8, are further determined as a function of the structural strength required and of the natural angle of repose of the material that is to be transported.

The angle at which the first portion 8a extends towards the interior of the container may preferably be determined by the following mathematical formula:

$$Ø1 \leq Ø2 - Ø3 - 90$$

where

Ø1–is the angle between the vertical wall 5, and the first portion 8a.

Ø2–is the angle the container is rotated in the unloading facility.

Ø3– is the natural angle of repose for the product to be transported.

As seen in Figure 7, the natural angle of repose 13 is dependent on the product 12 desired to be carried, and can be determined by pouring or dropping the material 12 on to a level plain so as to form a substantially conical hill. The angle of repose 13 is then determined as the angle between the horizontal plain 15, and a line extending from the base of the cone to the top of the hill.

In some circumstances, it may be more appropriate to use the following formula:

$$Ø1 \leq Ø2 - Ø3 - Ø4 - 90$$

where

Ø4–is the cohesion of the material to be transported when wet.

For a bottom dumping container 180° has to be added to the volume for Ø1. Alternatively, the formula may be amended by changing the -90° to +90°. In a further alternative Ø2 for a bottom dumping container may be considered to be 180°.

Essentially, the shape of the first portion 8a of the internal ridge 8 can be determined on the basis of the natural angle of repose 13 of the material which is to be carried. The second portion 8b will depend on the structural and manufacturing requirements of the container and may be derived from detailed structural analysis of the structural strength and stiffness requirements of the

container. Whilst the second portion 8b may have a similar angle and length to the first portion 8a, this is not a requirement of the internal ridge. That is, the second portion 8b may be shaped differently to the first portion 8a, in that it may be curved, or flat. Alternatively, the length of the second portion 8b may be different to that of the first portion 8a, and accordingly the angle of the second portion 8b between the wall 5 and the second portion 8b will be different. The shape of the second portion 8b of the internal ridge 8 will depend on the limitations, such as space constraints, of the container, and on the number of internal ridges 8 in the wall 5, and to some degree on manufacturing facilities. Whereas the first portion 8a is based on the angle of repose 13 as discussed above, the second and possibly third portions 8b, 8c are chosen to complete the internal ridge 8, and fulfil the structural requirements of the container.

The length and shape of the internal ridge 8, will depend on the structural requirements of the side walls 5 and the base 6. It will also depend on the spacing between supporting frame members 9, and the natural angle of repose of the material. As the distance or spacing between the supporting frame members 9 increases, it will be necessary to increase the depth 16 of the internal ridge 8, to ensure the necessary structural strength. Accordingly, it is possible to design a container specifically for a certain type of material to be transported, by considering the mass of the material and the pressure the material will place on the walls of the container.

A container constructed with an internal ridge of the present invention provides a container that is able to transport bulk product. Furthermore, the internal ridge acts as an in-built longitudinal structural stiffener. This internal ridge, then ensures that the structural requirements, such as strength, fatigue resistance, and buckling capacity, are met, while ensuring that more product can be loaded into a container that has the same exterior dimensions as a conventionally designed container. This difference in carrying capacity can be seen in Figure 5, where the shape of a new container of the present invention is superimposed over a conventional container. The shaded area of Figure 5 shows the extra volume that may be loaded into the new container of the present invention.

The internal ridge 8 is designed to run along the length of the side wall 5 between the supporting frame members 9. Depending on the requirements of the container, for example the placement of locking members 16, the shape and design of the internal ridges 8 may vary between the supporting frame members 9, as seen in Figure 2a. Alternatively, as shown in Figure 3a the internal ridge 8 may be consistent in each panel of the side wall 5.

As can be seen from the figures, it is also preferable to include a partial internal ridge 10 at the top of the container. This partial internal ridge 10 may be formed by a first portion which extends at an angle towards the interior of the container. That is, the partial internal ridge 10 does not include the second portion of the internal ridge 8. Ideally, such a partial internal ridge 10 would also include an additional strengthening member 11 which forms the rim of the container. This rim 11 effectively compensates for the omission of the second portion of the internal ridge, thereby ensuring that the structural strength is sufficient. It will be understood that finite element analysis or other structural analysis can be used to determine the depth of the internal ridge and the thickness of the material to be used for the side wall of the container. Again the depth may be calculated depending on the spacing of the supporting frame members 9, and on the pressure exerted by the material to be carried. The exact figure is derived by applying strength of material theory as well as theories of structural mechanics.

The number and the placement of the internal ridges may be dependent upon the size of the container. As can be seen by a comparison of Figures 1 and 2, the addition of the internal ridge 8 reduces the number of strengthening ribs 4 required on a conventional container. This reduction in the number of ribs decreases the weight of the container, and also improves the aerodynamics of the container. Both these features result in a more cost effective container.

The internal ridge 8 may also include a third portion 8c which joins the first portion 8a to the second portion 8b. This third portion 8c may be used to further improve the structural requirements of the internal ridge 8. Accordingly, depending upon the application, this third portion 8c may be flat or concave. Further, it may run parallel to the wall 5, or extend at some angle relative to the

wall 5. Generally, the longer the third portion 8c is, the stronger the internal ridge 8 is. However, if the third portion 8c is longer then the first portion 8a then some structural strength is lost, and accordingly it is desirable that the third portion 8c not exceed the length of the first portion 8a. Whether a third portion 8c is adopted will again depend on the required strength of the structure as well as any space constraints on the container.

The container of the present invention may be used for bulk transportation by either road or rail. It may also be adapted to be used on containers designed for rotary dumping or tipping, or for bottom dumping. The orientation of the internal ridge will depend upon this unloading method. That is, the first portion 8a is always aligned with the flow of the product being unloaded so as to ensure that no product gets caught up inside the container. If the angle of the internal ridge is not designed so as to ensure that all the product was unloaded, it would be possible for trapped product to unbalance a container thought to be unloaded, thereby possibly causing derailment or collapsing of the container. It will also be understood that the base 6 of the container may also include at least one internal ridge, thereby strengthening the base of the container. The internal ridges running along the base of the container, may go over the wheels and extend through substantially the entire length of the container. Such floor ridges can be constructed having two main functions. One being operational, to bridge over the wheel thereby adding greater interior volume, and secondly structural as the ridge is again designed to provide structural strength. The parameters of the floor ridge are established using structural analysis. The height of the floor ridge is a function of the depth of the container, of the material properties of the product carried, and of the size of the wheels. The dimensions of the floor ridge will also depend on the spacing of the supporting members.

By the addition of at least one internal ridge in the wall of the container, the present invention results in a container that is lighter than conventional containers as the side wall containing the internal ridge does not require as many structural reinforcements as conventional containers, since the internal ridge itself adds to the structural strength of the wall. Again this can be seen by

comparison of Figures 1 and 2, whereby the number of ribs or strengthening elements is less than in the original design. The decrease in the number of ribs 9 also leads to a cheaper container. The decrease in the number of vertical elements, and protruding parts generally improves the aerodynamic shape of the container, thereby making a more efficient and economical container. Further, because fewer welds are required the design ensures that there are fewer areas of stress concentration, thereby making the improved container more fatigue resistant.

As an example of the present invention, for a container designed to carry bulk ore from Mt Whaleback in Western Australia, the overall dimensions of the container could be:

Length = 9.068 metres

Breadth = 3.200 metres

Depth = 2.278 metres

As to the ridge, assuming that the iron ore has a bulk density of 27.1 KN/m^3, an angle of repose of 35° and a side rotation of 137° for unloading, then the internal ridge characteristics could be as follows:

Ø1, the angle between the vertical wall 5 and the first portion of the ridge 8a, is calculated at 12°. Structural analysis has determined that the first internal ridge portion 8a ideally starts at a vertical height of 350mm from the base; is angled inwards at 10 degrees (which is less that the calculated 12° to account for any adhesion of the material) and continues inwards until it reaches a vertical height of 800mm from the base, which is equivalent to a 75mm internal ridge depth. A third portion 8c is required of 95mm vertical height and the second portion 8b joins the third portion 8c, to the vertical wall 5, finishing at an overall height of the completed ridge 1040mm from the base.

Ideally, in the longest wall section an extra reinforcing member would also be added to the internal ridge to provide structural strength.

The main benefits of this design compared to existing bulk iron ore containers carrying the same stated ore are that the overall weight of the container is reduced by approximately 18% due to the improved structural efficiencies gained from the new structural wall and floor shape. Further, the

payload of the improved container is increased by approximately 1% over that of a conventional container due to the increase in the container volume.

In addition, the aerodynamic characteristics of the shape reduce the drag coefficient on the side walls by 19% which will result in improved fuel economy for the operator.

In summary, the present invention provides a container that fits into the prescribed parameters, such as the maximum dimensional requirements, but still allows for an increased payload capacity without sacrificing structural strength. The more efficient structural design means that the container is lighter and more aerodynamic. Furthermore, the shape of the container is such that the product unloads easily and no product is left in the container after unloading operations. The angle and shape of the side walls and internal ridge are designed to take into consideration the products natural repose angle as well as the operators loading methodology, thereby ensuring that efficient unloading is achieved.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A container for transporting bulk material including two side walls, two end walls and a base, wherein at least one said side wall includes at least one ridge running the length of said at least one side wall.

2. A container for transporting bulk material including two side walls, two end walls, and a base; said side walls including a plurality of vertical reinforcing members spaced along the length of said side wall, wherein said side wall between at least one adjacent pair of said reinforcing members includes at least one internal ridge running therebetween.

3. A container as claimed in claim 2 further including at least one internal ridge between each of said reinforcing members.

4. A container as claimed in claim 2 or 3 including additional reinforcement running along said internal ridge between each of said reinforcing members.

5. A container as claimed in any one of claims 2 to 4, further including at least one internal ridge between one said end wall and a first reinforcing means.

6. A container as claimed in any preceding claim wherein said ridge includes a first wall portion angled from said wall towards the interior of said container, and a second wall portion rejoining said first wall portion to said wall.

7. A container as claimed in claim 6 wherein the angle of said first wall portion is in the direction of flow during unloading of the material to be transported.

8. A container as claimed in any one of claims 1 to 5, wherein said internal ridge includes a first wall portion deflected inwardly a progressively increased degree relative to the intersection of said side wall and said base, and a second wall portion extending from said first wall portion and being deflected outwardly

a progressively decreased degree relative to the intersection of said side wall and said base.

9. A container as claimed in any one of claims 1 to 8 wherein the angle of said first wall portion is given by:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - 90$$

where:

$\varnothing 1$ - is the angle between said side wall and said first wall portion,

$\varnothing 2$ - is the angle said container is rotated during unloading of said container, and

$\varnothing 3$ - is the natural angle of repose of material to be transported in said container.

10. A container as claimed in any one of claims 1 to 8 wherein the angle of said first wall portion is given by:

$$\varnothing 1 \leq \varnothing 2 - \varnothing 3 - \varnothing 4 - 90$$

where:

$\varnothing 1$ - is the angle between said side wall and said first wall portion,

$\varnothing 2$ - is the angle said container is rotated during unloading of said container,

$\varnothing 3$ - is the natural angle of repose of material to be transported in said container, and

$\varnothing 4$ - is the cohesion of said material to be transported when wet.

11. A container as claimed in any preceding claim wherein said first and second wall portions are symmetrical.

12. A container as claimed in any preceding claim wherein said second wall portion is convex or concave.

13. A container as claimed in any preceding claim wherein said first wall portion is aligned with the flow of material during unloading of said container.

14. A container as claimed in any preceding claim wherein said ridge further includes a third wall portion between said first wall portion and said second wall portion.

15. A container as claimed in claim 14 wherein said third wall portion is concave.

16. A container as claimed in claim 14 wherein said third wall portion is flat or straight.

17. A container as claimed in claim 16 wherein said third wall portion is parallel to said side wall.

18. A container as claimed in claim 16 wherein said third wall portion is angled relative to said side wall.

19. A container as claimed in any one of claims 12 to 18 wherein said first wall portion is equal to or longer than said third wall portion.

20. A container as claimed in any preceding claim wherein at least one said side wall further includes a partial ridge along the top or rim of said at least one side wall, said partial ridge being formed by a fourth wall portion, said fourth wall portion being equivalent to said first wall portion.

21. A container as claimed in claim 20 wherein said partial ridge further includes a strengthening member along the periphery of said fourth wall portion, said strengthening member forming the rim of said container.

22. A container as claimed in any preceding claim wherein said base of said container includes at least one ridge extending substantially along the length of said base.

23. A container as claimed in claim 22 wherein said at least one ridge along said base is located about wheel or track positions of a support for said container.

24. A container substantially as hereinbefore described with reference to figures 2a, 2b, 3a, 3b, 4b, 6 or 8.

25. A container as claimed in any preceding claim for use in transportation of bulk material by road.

26. A container as claimed in any preceding claim for use in transportation of bulk material by rail.